# Analysis of Petroleum Product Prices (1992-1997) and The Feasibility of a California Petroleum Product Reserve


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***Disclaimer: The views and conclusions in this document are those of the staff of the Fuel Resources Office and should not be interpreted as necessarily representing the policies of either the California Energy Commission or the State of California.***

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# Introduction

California's unique diesel and gasoline fuel market can potentially lead to greater price volatility of petroleum products. Since the state's maximum refining capacity closely matches current demand, any production loss significantly impacts product prices. Prior to the introduction of CARB fuels, petroleum products from out-of-state easily flowed to California. However, the unique fuel specifications for petroleum products used in the California market have increased the time between out-of-state product production and its market availability. Further, to minimize federal tax payments and inventory carrying cost, refiners limit their crude oil and product inventory level, potentially adding to price volatility.

Over the last two years, gasoline and diesel prices have exhibited wide fluctuations and this market behavior has not been accepted as reasonable or desirable by the general public and large volume users of gasoline and diesel. The potential for greater price volatility of petroleum products has created the need to examine what, if anything, the state can do to ensure price stability in the marketplace.

The *1993 Fuels Report* considered the creation of a regional petroleum product reserve to alleviate the adverse effects of volatile prices. However, the *1993 Petroleum Product Reserve Feasibility* study by Invictus Corporation concluded that "... the proposed storage facility is not economically justified at present." Since the completion of the study, the introduction of CARB fuels has created a unique petroleum product market in California.

Significantly different market conditions -- in both the electricity and the petroleum products markets -- resulted in a proposal to revisit the concept of a California Petroleum Product Reserve. Starting in the 1980s, air quality regulation required electric utilities in Southern California to switch to natural gas, thus leaving the utilities with large volumes of unneeded residual fuel oil storage capacity. Southern California Edison, for example, possesses sixteen million barrels of storage space, with approximately three million barrels now used for petroleum product storage. These facilities are linked to refinery centers and common carrier pipelines and, therefore, can be easily integrated into the supply system.[1] Since these facilities already exist, the economic feasibility of a California Petroleum Product Reserve (CPPR) may significantly change when compared with the conclusions of the 1993 Invictus study, which only considered the construction of new facilities.

The unused residual fuel oil storage is almost double current petroleum product storage capacity within the fifth district of the Petroleum Administration for Defense (PADD V[2]). Expanded inventories of gasoline and diesel could dampen price increases during periods of refinery production loss, thus providing consumers more stable prices. *This study examines the feasibility and possible price stabilizing effects of converting the existing electric utility petroleum storage capacity for storing refined petroleum products, namely CARB gasoline and diesel.*

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[1] Information from Edison Pipeline and Terminal Company.
[2] Includes California, Washington, Oregon, Utah, Nevada, Alaska, and Hawaii.

## Analysis and Methodology

To answer the questions arising from the proposal to construct a CPPR, this study divides the analysis into four sections, each of which addresses different aspects of the problem. The four sections are:

- Volatility Analysis: An examination of price movements of petroleum products between 1992 and 1997.

- Regression Analysis: A determination of the variables that drive petroleum product prices.

- Benefit-Cost Analysis: An evaluation of the economic feasibility of a California Petroleum Product Reserve.

- Alternative to Wet Barrels: A brief examination of futures and forward contracts specifically designed for California's unique petroleum product market.

Data sources (1992 - 1997) included:

- PLATT'S Oilgram: Daily issues supplied the crude oil data. This analysis required representative weekly prices. Alaska North Slope (ANS) was chosen since 45-50 percent of the crude oil consumed by California refiners come from the Alaska North Slope.

- Oil Price Information Service (OPIS): Weekly issues supplied wholesale gasoline and diesel prices. The analysis examined two areas of the state, namely Los Angeles and San Francisco.

- Petroleum Industry Information Reporting Act (PIIRA): Weekly aggregated data compiled by the Energy Commission staff supplied the inventory data for Northern and Southern California.

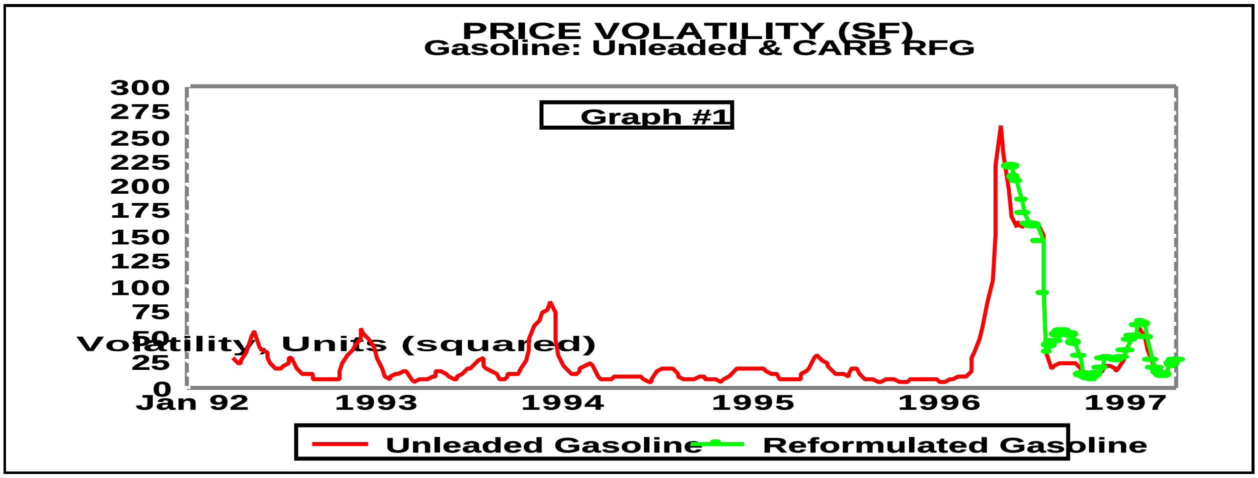
- Caltrans: Annual publications supplied the vehicle miles traveled (VMT) and consumption data.

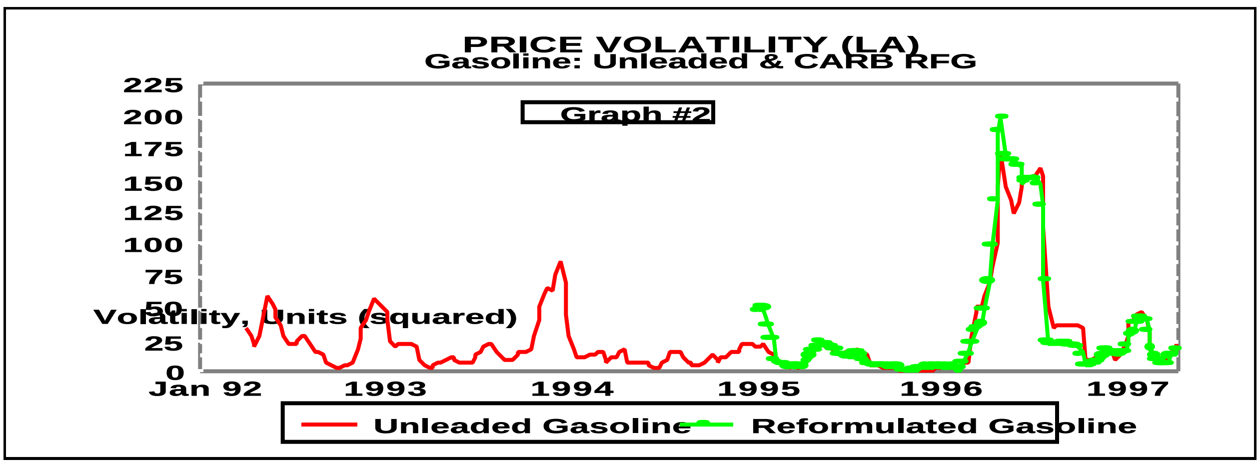
### Volatility Analysis

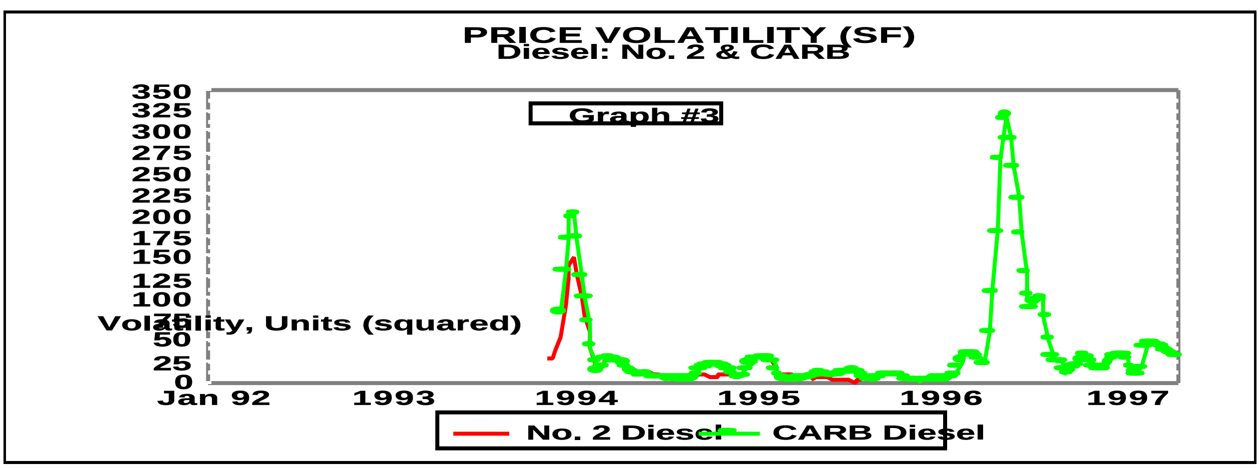
The study used a variance analysis of product prices between 1992 and 1997 to examine volatility. Using thirteen data points at any particular point in time, instantaneous volatilities were calculated.

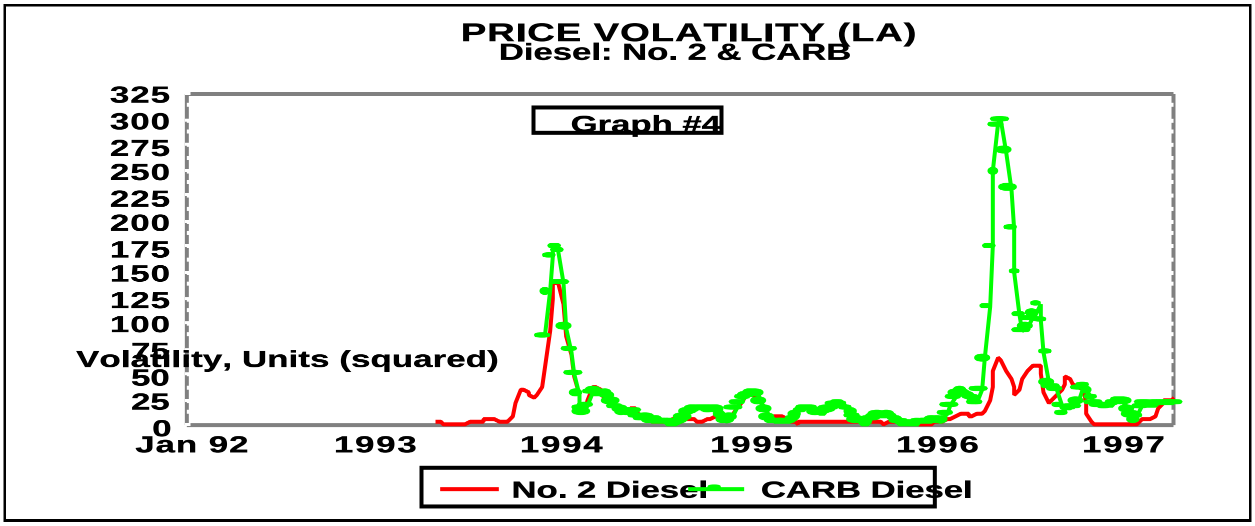
Results

Graphs #1 through #4 illustrate the results of the price volatilities determined for petroleum product fuels consumed in Los Angeles and San Francisco.






Conclusions

The analysis led to the following conclusions:

a. For the two year period prior to January 1996, volatility of regular unleaded gasoline prices in Los Angeles averaged about ten variance units[3] (VUs). Diesel prices in Los Angeles averaged about seven VUs. However, after January 1996, volatility substantially increased, averaging about 30 VUs for gasoline and about 25 for diesel. In early 1996, price volatility for both gasoline and diesel reached and surpassed 200 VUs.

b. Prices in San Francisco exhibited similar behavior.

c. Since the introduction of CARB fuels, price volatility of petroleum products has increased.

d. The large increase in volatility of diesel fuels in 1993 coincided with the introduction of CARB specifications. Both diesel and gasoline exhibited similar behavior in early 1996 when CARB specifications for gasoline became effective.

**Regression Analysis**

This part of the study determined the driving forces behind petroleum product prices. Gasoline and diesel prices were regressed against crude oil prices, inventory levels, vehicles miles traveled, and consumption. Four regression models attempted to capture the relation between the dependent variables (gasoline and diesel prices) and the independent variables (crude oil prices, inventory levels, vehicles miles traveled, and consumption).

· Model #1: This model regressed crude oil prices against the petroleum product prices (gasoline and diesel).

[3]Price-squared is the variance unit in this analysis.

- Model #2: This model regressed crude oil prices and inventory levels against the petroleum product prices (gasoline and diesel).

- Model #3: This model regressed crude oil prices, inventory levels, and VMT levels against the petroleum product prices (gasoline and diesel).

- Model #4: This model regressed crude oil prices, inventory levels, and consumption levels against the petroleum product prices (gasoline and diesel).

The mathematical equations below represent the regression models for Los Angeles gasoline prices:

$G_p = J_0 + J_1 * CO_p + e$ ....................................................(Model #1)

$G_p = J_0 + J_1 * CO_p + J_2 * Inv_L + e$ ................................(Model #2)

$G_p = J_0 + J_1 * CO_p + J_2 * Inv_L + J_3 * VMT + e$ ...........(Model #3)

$G_p = J_0 + J_1 * CO_p + J_2 * Inv_L + J_3 * Gas_C + e$ ............(Model #4)

where $G_p$ = Gasoline price, $/bbl
$CO_p$ = Crude oil price, $/bbl
$Inv_L$ = Inventory Available, mbbls
VMT = Vehicle Miles traveled, mmVMTs
$Gas_C$ = Gasoline Consumption, mbbls
e = error term
$J_0$, $J_1$, $J_2$, and $J_3$ are regression coefficients.

Similar equations simulated price behavior of diesel in Los Angeles and gasoline and diesel in San Francisco. The regression analysis produced R-squared values, which explain how changes in the dependent variable *can be explained* by changes in the independent variables.

In this analysis, all variables were smoothed using 13-week and 26-week moving averages. Moving averages aid in identifying the secular trend of a time series because the averaging modifies the effect of short-term (cyclical or seasonal) variation.[4] In this analysis, the 13- and 26-week smoothing created new datasets, from which estimates of weekly price variations were made.

[4] Mendenhall, William and Sincich, Terry, "A Second Course in Business Statistics: Regression Analysis."

## Results

a. Tables #1 and #2 demonstrate the results of the regression analysis.

b. Using 13-week smoothing, changes in crude oil prices explain between 55 and 83 percent of the changes in petroleum product prices (Model #1).

c. Using 26-week smoothing, the explanation rises to 60 to 90 percent (Model #1).

d. Adding inventory levels to the regression equation raises the explanation to 57 to 83 percent in the 13-week smoothing case. The 26-week smoothing regression produced explanations between 67 and 90 percent (Model #2).

e. Vehicles miles traveled and consumption added little to the regression analysis. The data required manipulations that may have affected their usefulness (Model #3 and Model #4). This analysis used weekly data. However, Caltrans provides its data on a monthly and quarterly basis. Thus, estimates were used to divide the data into weekly units.

**Table #1**
**Regression Analysis (13-weeks smoothed)**
**R-Squared**

| | Product Price Track | Model #1 | Model #2 | Model #3 | Model #4 |
|---|---|---|---|---|---|
| **Differential Price Tracks*** | Unleaded Gasoline (LA) | 0.83 | 0.83 | 0.85 | 0.83 |
| | CARB RFG (LA) | 0.55 | 0.57 | 0.61 | 0.58 |
| | Unleaded Gasoline (SF) | 0.71 | 0.76 | 0.77 | 0.76 |
| | CARB RFG (SF) | ** | ** | ** | ** |
| | No. 2 Diesel (LA) | 0.55 | 0.60 | 0.61 | 0.61 |
| | CARB Diesel (LA) | 0.56 | 0.61 | 0.63 | 0.61 |
| | No. 2 Diesel (SF) | ** | ** | ** | ** |
| | CARB Diesel (SF) | 0.58 | 0.64 | 0.65 | 0.65 |
| **Single Price Track*** (1992-1997)** | Gasoline (LA) | 0.73 | 0.74 | 0.76 | 0.74 |
| | Gasoline (SF) | 0.65 | 0.66 | 0.68 | 0.67 |
| | Diesel (LA) | 0.58 | 0.60 | 0.60 | 0.61 |
| | Diesel (SF) | 0.58 | 0.64 | 0.66 | 0.65 |

Model #1: Crude Oil Price as the independent variable
Model #2: Crude Oil Price & Refinery Inventory as independent variables
Model #3: Crude Oil Price, Refinery Inventory, & Vehicles Miles Traveled as independent variables
Model #4: Crude Oil Price, Refinery Inventory, & Consumption as independent variables

*Price track which separates CARB fuels and non-CARB fuels
**Limited data, unable to establish regression
***Price track which combines CARB fuels and non-CARB fuels throughout the study period

**Table #2**
**Regression Analysis (26-weeks smoothed)**
**R-Squared**

| | **Product Price Track** | **Model #1** | **Model #2** |
|---|---|---|---|
| **Differential Price Tracks** | Unleaded Gasoline (LA) | 0.90 | 0.90 |
| | CARB RFG (LA) | 0.64 | 0.69 |
| | Unleaded Gasoline (SF) | 0.77 | 0.82 |
| | CARB RFG (SF) | ** | ** |
| | No. 2 Diesel (LA) | 0.61 | 0.67 |
| | CARB Diesel (LA) | 0.70 | 0.76 |
| | No. 2 Diesel (SF) | ** | ** |
| | CARB Diesel (SF) | 0.80 | 0.84 |
| **Single Price Track (1992-1997)** | Gasoline (LA) | 0.81 | 0.84 |
| | Gasoline (SF) | 0.69 | 0.70 |
| | Diesel (LA) | 0.64 | 0.67 |
| | Diesel (SF) | 0.64 | 0.69 |

Model #1: Crude Oil Price as the independent variable
Model #2: Crude Oil Price & Refinery Inventory as independent variables

**Limited data, unable to establish regression

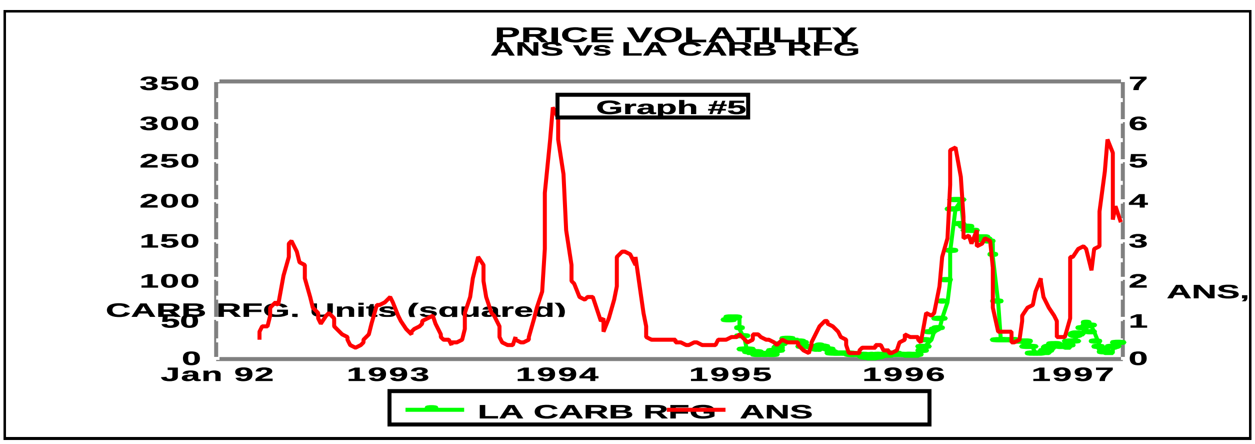
Conclusions

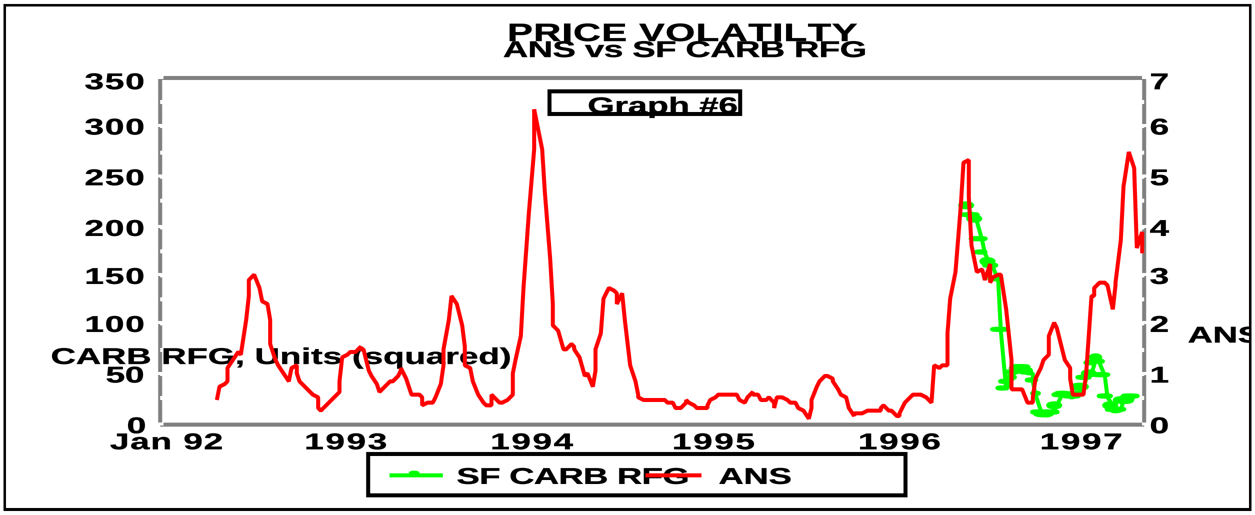
a. Crude oil price is a reliable indicator of petroleum product prices. See graphs #5, #6, #7, and #8 below, which show the relationship between the volatility of crude oil (ANS) prices and CARB petroleum products. Appendix B contains similar graphs for the non-CARB petroleum products.

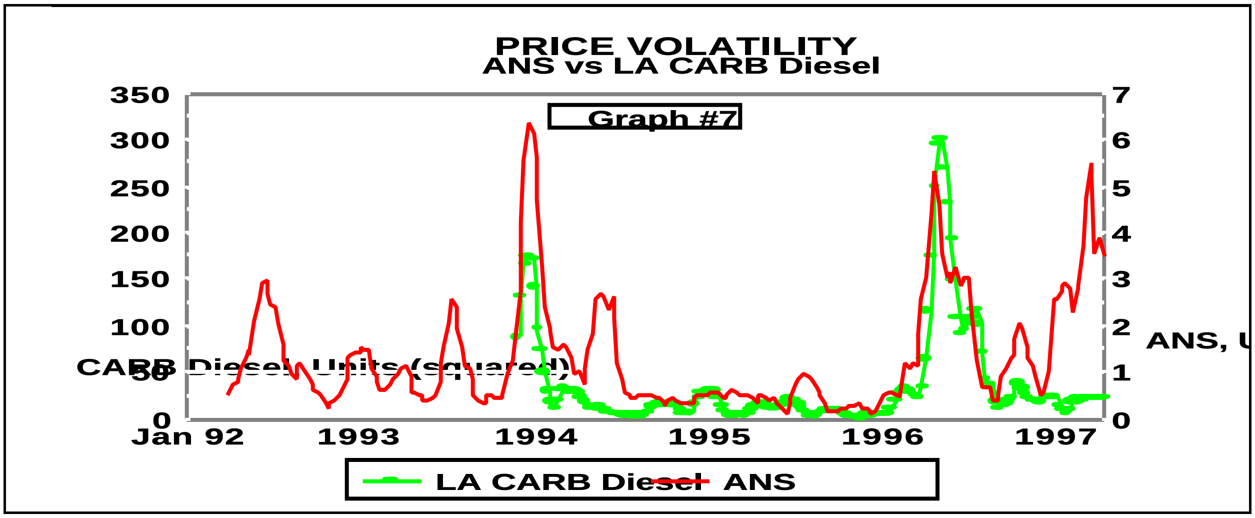
b. The volatility of product prices so closely match that of crude oil prices that the graphical illustrations often overlap.

c. The predictive ability of the regression models improves with the addition of inventory levels, though at a much lower rate than crude oil prices.

d. Other major crudes, such as West Texas Intermediate (WTI), demonstrated similar correlations with gasoline and diesel prices. In this analysis, WTI prices exhibited a 97 percent correlation with ANS prices.




PRICE VOLATILTY
ANS vs SF CARB RFG
Graph #6
350
300
250
200
150
100
50
0
CARB RFG, Units (squared)
7
6
5
4
3
2
1
0
ANS
Jan 92
1993
1994
1995
1996
1997
SF CARB RFG
ANS


PRICE VOLATILITY
ANS vs LA CARB Diesel
Graph #7
350
300
250
200
150
100
50
0
CARB Diesel, Units (squared)
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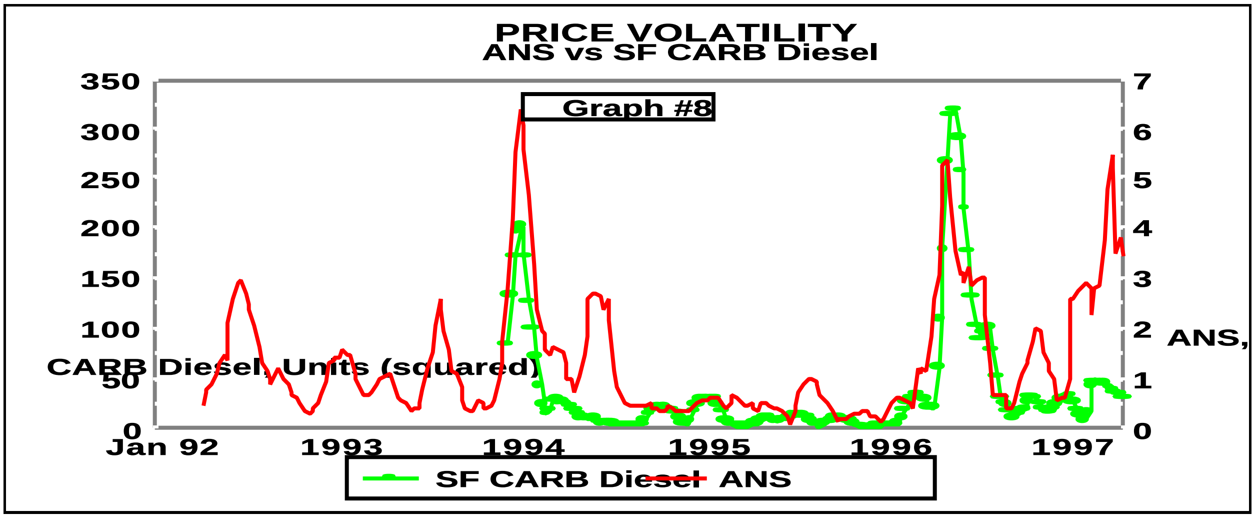
6
5
4
3
2
1
0
ANS, U
Jan 92
1993
1994
1995
1996
1997
LA CARB Diesel
ANS


PRICE VOLATILITY
ANS vs SF CARB Diesel
Graph #8
350
300
250
200
150
100
50
0
CARB Diesel, Units (squared)
7
6
5
4
3
2
1
0
ANS,
Jan 92
1993
1994
1995
1996
1997
SF CARB Diesel
ANS

### Benefit-Cost Analysis

This section of the study examines the cost and benefits of developing a California Petroleum Product Reserve. For any given set of independent variables and coefficients from the regression analysis, a gasoline or diesel price can be estimated. *Inventory requirements needed for lowering product prices by a specific amount during an inventory release were calculated using the regression equations obtained from Model #2, Table #2*.[5] Table #3 displays the requirements for lowering prices by 4 cents, 8 cents, and 12 cents.

**Table #3**
**Inventory Requirements**

| | | Inventory Requirements to lower price by: (thousands of bbls) | | |
|---|---|---|---|---|
| **Product Price Track** | **Inventory Coefficient, β** | **4 cents** | **8 cents** | **12 cents** |
| CARB RFG (LA) | -0.0027 | 622.0 | 1244.0 | 1867.0 |
| CARB RFG (SF)** | -0.0033 | 509.0 | 1018.0 | 1527.0 |
| CARB Diesel (LA) | -0.0071 | 237.0 | 473.0 | 710.0 |
| CARB Diesel (SF) | -0.0049 | 343.0 | 686.0 | 1029.0 |

**Inventory requirements developed using the regression analysis of unleaded gasoline in SF

To complete this portion of the analysis, the study must estimate several parameters:

- Total annualized cost of the CPPR: This portion of the analysis assumed a 20-year project life. The cost included cost of converting the existing storage tanks, the cost of the initial inventory, and the cost of storage (@ 30 cents/bbl/mth).

- Total benefits from lower prices: Since the release of inventory will lower prices, petroleum product consumers will realize increased consumer disposable income over the period of release. Stored inventory will be used to make up supply shortfalls. In the case where prices are lowered by 12 cents/gallon, inventory will last 2.5 weeks, assuming a loss of about 100,000 bbls/d of gasoline refining capacity and about 40,000 bbls/d of diesel refining capacity.

- Total disbenefit: An indirect cost consumers will pay when restocking occurs, since filling and re-filling the reserve will add upward pressure to petroleum product prices. The study assumed that the reserve will release petroleum products once per year and restocking will take about four weeks.

- The Benefit-Cost Ratio: This measure of economic feasibility answers the question of whether the reserve will serve the long-term interest of petroleum product consumers.

The benefit-cost analysis illustrated in Table #4 assumes that the inventory volumes will lower prices by 12 cents/gal. or $5.04/bbl in periods of supply shortfall. This price differential will increase consumers' disposable income by 12 cents for each gallon of petroleum products consumed during the shortfall period.

[5]See Appendix A for an example of the calculation.

**Table #4**
**Benefit-Cost Analysis**
**Los Angeles Area (Los Angeles & Orange Counties)**
(Assuming prices are 12 cents lower)

| | |
|---|---|
| **COSTS**: | |
| Total Conversion Cost[6] | |
| RFGasoline (1,867 mbbls; approx. 4 tanks ... $3,055,000/tank x 4 tanks) | $12,220,000.00 |
| CARB Diesel (710 mbbls; approx. 2 tanks ... $2,305,000/tank x 2 tanks) | 4,610,000.00 |
| Permitting and Miscellaneous (10% of above total) | 1,683,000.00 |
| **Subtotal** | **$18,513,000.00** |
| Initial Inventory Cost | |
| RFGasoline ($29.00/bbl ... 1,867,000 bbls x $29.00/bbl) | $54,143,000.00 |
| CARB Diesel ($30.00/bbl ... 710,000 bbls x $30.00/bbl) | 21,300,000.00 |
| **Subtotal** | **$75,443,000.00** |
| **Total Initial Cost** | **$93,956,000.00** |
| Annualized Cost (assuming 20 year life) | $12,108,608.19 |
| Annual Storage Cost @ $0.30/bbl/mth) | $9,277,200,00 |
| **Total Annualized Cost** | **$21,385,808.19** |
| **TOTAL BENEFITS:** | |
| Annual gasoline consumed in LA area, bbls (Caltrans data) | 109,389,286 |
| Weekly gasoline consumed in LA area, bbls | 2,103,640 |
| Weekly diesel consumed in LA area (Caltrans data) | 274,000 |
| Weekly increased disposable income @ $5.04/bbl or 12 cents/gal. ((2,103,640 + 274,000) x $5.04/bbl) | $11,983,306.15 |
| Total disposable income saved ($11,983,306.15/wk x 2.5 weeks) (Storage volume will last about 2.5 weeks if the LA area loses about 100,000 bbls/d of gasoline & and equivalent amount of diesel productive capacity) | $29,958,265.38 |
| **TOTAL DISBENEFTS** | |
| Total disbenefit from restocking (assuming one release per year) Restocking generates a disbenefit because large purchases of petroleum products will push prices higher than they otherwise would have been | |
| **Assume** restocking takes four weeks and prices are on average four cents/gallon higher (the disbenefit: 4 wks x 0.04 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $15,977,741.54 |
| **Assume** restocking takes four weeks and prices are on average two cents/gallon higher (the disbenefit: 4 wks x 0.02 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $7,988,870.77 |
| **Assume** restocking takes four weeks and prices are on average zero cents/gallon higher (the disbenefit: 4 wks x 0.00 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $0.00 |

[6]Information provided by Edison Pipeline & Terminal Company.

Results

The Benefit-Cost Ratio, determined under three scenarios of prices change during restocking, answers the question of economic feasibility. The equation for calculating the measure follows:

Benefit-Cost Ratio = (Total Benefits - Total Disbenefits)/Total Annualized Cost.

The above information produced the results shown in Table #5.

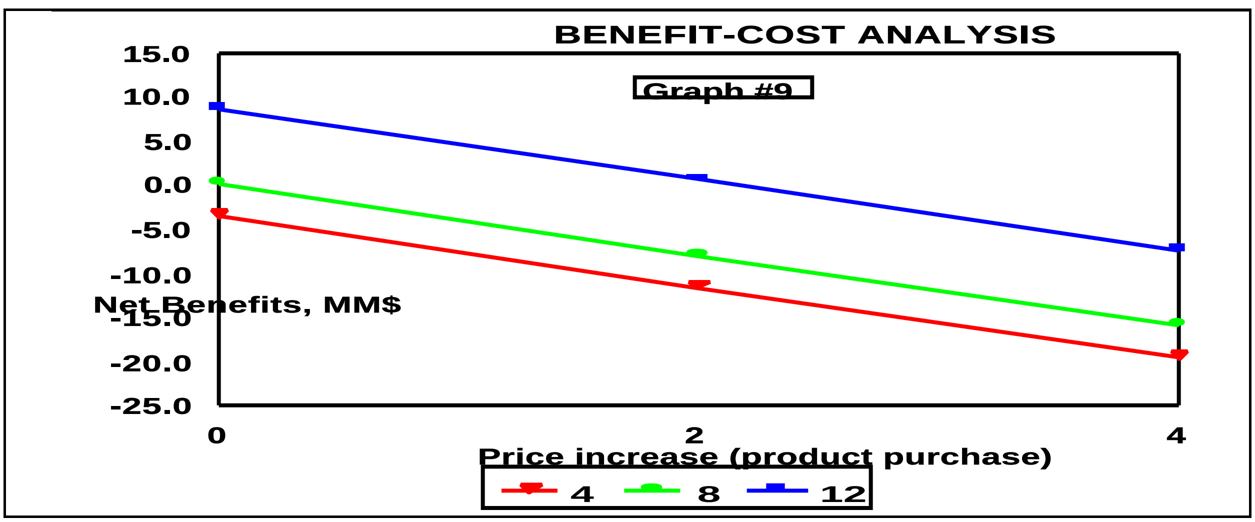
**Table #5**
**Results of Benefit-Cost Analysis**
**(Total Net Benefits/Total Cost)**

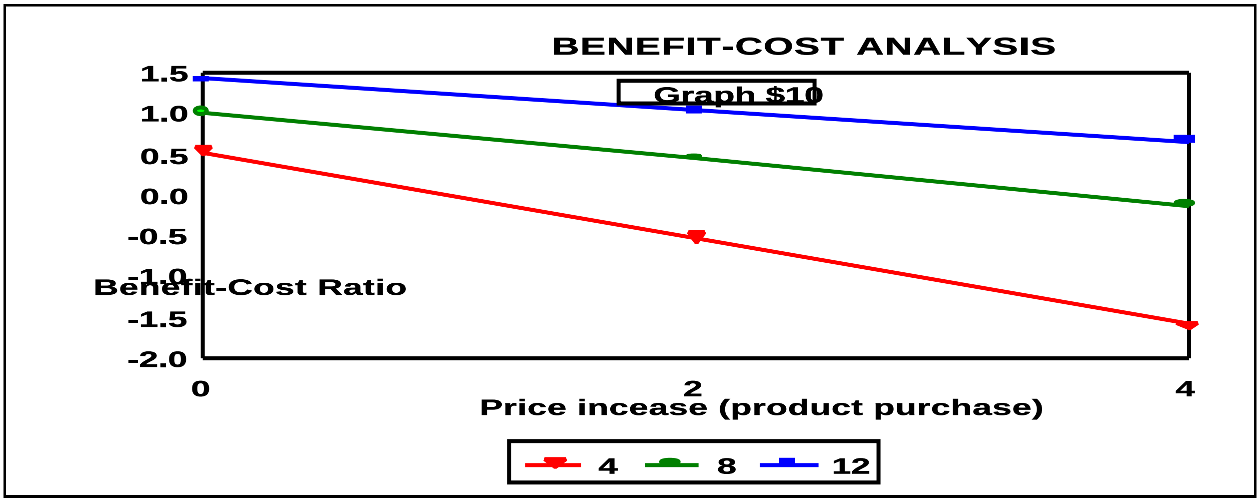
| Price During Restocking | Benefit Cost Ratio** |
|---|---|
| Four cents/gallon higher | 0.654 |
| Two cents/gallon higher | 1.027 |
| Zero cents/gallon higher | 1.401 |

**Benefit-Cost Ratio = (Total Annual Benefits - Disbenefits) / Total Annualized Cost

Appendix C contains the analysis for prices that are 4 cents and 8 cents lower.

Using various scenarios, graph #9 illustrates the net benefits and graph #10 illustrates the resulting benefit-cost ratios. The graphs represent the net effect of price increases due to purchases of petroleum products and price reductions due to product release. Price increases due to the purchases are represented on the horizontal scale in each graph. The analysis examined price increases of 0, 2 and 4 cents. Each line on the graph illustrates different price reductions due to product release. This analysis examined price reductions of 4, 8 and 12 cents.






Conclusions

a. If during restocking of inventory, prices rise above two cents, the CPPR will be uneconomic. Overall, the CPPR will be marginally economic at best.

b. This analysis did not consider how refiners will respond to increased inventory. The considerable volume of inventory available from the CPPR, may induce refiners to lower their stock, thus negating the potential positive effect of the reserve.

**Alternative to Wet Barrels: Paper Barrels[7]**

Presently, the New York Mercantile Exchange and other markets trade futures and forward contracts in refined products. California's unique petroleum product specifications, however, segregates the national market. Refined products are not readily substitutable.

Annually, California consumes approximately 2.1 billion gallons of diesel and 13 billion gallons of gasoline. The state's relatively large refined product market creates the opportunity for an active paper market to develop. The state can encourage the development of financial instruments, which participants can use for risk management.

Financial (paper) markets allow consumers, large and small[8], to lock in price levels and thus insure against unexpected adverse price movements. In general, paper markets allow individuals and firms to transfer their exposure to price fluctuations to traders willing to accept this risk with the expectation of compensation. Since traders hedge adverse price movements in both directions, financial instruments tend to stabilize prices.

Financial instruments specifically designed for California's unique petroleum product market would provide refiners and consumers with greater risk management tools. The trading of futures and forward contracts with differing characteristics and delivery points for similar products is not unprecedented. Contracts for West Texas Intermediate crude are traded on the New York Mercantile Exchange whereas

[7] Some information contained in this section came from Phillip K. Verleger, Jr.'s May 11, 1995 presentation.
[8] Small consumers can use financial markets by combining transactions with other market participants.

contracts for Brent crude are traded on the International Petroleum Exchange. These contracts differ in specifications and delivery points.

## General Results

a. Since the introduction of CARB fuels, California has experienced greater petroleum product price volatility.

b. Crude oil price reliably predicts petroleum product prices. Adding an inventory parameter improves the prediction.

c. The California Petroleum Product Reserve would be marginally economic at best.

d. The development of an active financial (paper) market could help market participants better manage their price risk exposure.

## General Conclusions

During periods of supply shortfall, less volatile product prices may increase the disposable income of consumers and greater inventory may moderate price increases. However, while a regional Petroleum Product Reserve can potentially stabilize prices, the long-term interest of California's petroleum product consumers will not be served by the creation of a Petroleum Product Reserve. An alternative to the creation of the CPPR may be the development of a financial paper market specifically designed for California's unique petroleum products.

# Appendix A
## Sample Calculation of Inventory Requirement

$G_p = J_0 + J_1 * CO_p + J_2 * Inv_L + e$ ................................(Model #2)

where $G_p$ = Gasoline price, \$/bbl
$CO_p$ = Crude oil price, \$/bbl
$Inv_L$ = Inventory Available, mbbls
$e$ = error term
$J_0$, $J_1$, and $J_2$ are regression coefficients.

To determine inventory changes:

Initial gasoline price will be determined by the following:

$G_p^a = J_0 + J_1 * CO_p^a + J_2 * Inv_L^a + e^a$................................1

New gasoline price:

$G_p^b = J_0 + J_1 * Co_p^b + J_2 * Inv_L^b + e^b$................................2

At a given crude oil price level, $Co_p^a = Co_p^b$

Subtracting equation 1 from equation 2:

$G_p^b - G_p^a = (J_2 * Inv_L^b - J_2 * Inv_L^a) + (e^b - e^a)$

Assume $e^b - e^a$   0 (this may not be strictly true)

Therefore:

$G_p^b - G_p^a = J_2 * (Inv_L^b - Inv_L^a)$

$(Inv_L^b - Inv_L^a) = (G_p^b - G_p^a) / J_2$

Change in required inventory to lower price = change in price / regression coefficient.

Example:

Since we are seeking a lower price, $(G_p^b - G_p^a)$ will be negative.
If change in price equals 12 cents/gal. (\$5.04/bbl) and regression coefficient equals -0.0027, then:

Change in required inventory to lower price = -12 / -0.0027 = approx. 1,867 mbbls.

# Appendix B

**Table #6**
**Benefit-Cost Analysis**
**Los Angeles Area (Los Angeles & Orange Counties)**
(Assuming prices are 8 cents lower)

| | |
|---|---|
| **COSTS**: | |
| Total Conversion Cost | |
| RFGasoline (1,244 mbbls; approx. 3 tanks ... $3,055,000/tank x 3 tanks) | $9,165,000.00 |
| CARB Diesel (473 mbbls; approx. 1 tanks ... $2,305,000/tank x 1 tanks) | 2,305,000.00 |
| Permitting and Miscellaneous (10% of above total) | 1,147,000.00 |
| **Subtotal** | **$12,617,000.00** |
| Initial Inventory Cost | |
| RFGasoline ($29.00/bbl ... 1,244,000 bbls x $29.00/bbl) | $36,076,000.00 |
| CARB Diesel ($30.00/bbl ... 473,000 bbls x $30.00/bbl) | 14,190,000.00 |
| **Subtotal** | **$50,266,000.00** |
| **Total Initial Cost** | **$62,883,000.00** |
| Annualized Cost (assuming 20 year life) | $8,104,065.83 |
| Annual Storage Cost @ $0.30/bbl/mth) | 6,181,200.00 |
| **Total Annualized Cost** | **$14,285,265.83** |
| **TOTAL BENEFITS:** | |
| Annual gasoline consumed in LA area, bbls (Caltrans data) | 109,389,286 |
| Weekly gasoline consumed in LA area, bbls | 2,103,640 |
| Weekly diesel consumed in LA area (Caltrans data) | 274,000 |
| Weekly increased disposable income @ $3.36/bbl or 8 cents/gal. ((2,103,640 + 274,000) x $3.36/bbl) | $7,988,870.77 |
| Total disposable income saved ($7,988,870.77/wk x 1.8 weeks) (Storage volume will last about 2.5 weeks if the LA area loses about 100,000 bbls/d of gasoline & and equivalent amount of diesel productive capacity) | $14,379,967.38 |
| **TOTAL DISBENEFITS** | |
| Total disbenefit from restocking (assuming one release per year) | |
| Restocking generates a disbenefit because large purchases of petroleum products will push prices higher than they otherwise would have been | |
| **Assume** restocking takes four weeks and prices are on average four cents/gallon higher (the disbenefit: 4 wks x 0.04 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $15,977,741.54 |
| **Assume** restocking takes four weeks and prices are on average two cents/gallon higher (the disbenefit: 4 wks x 0.02 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $7,988,870.77 |
| **Assume** restocking takes four weeks and prices are on average zero cents/gallon higher (the disbenefit: 4 wks x 0.00 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $0.00 |

**Table #7**
**Benefit-Cost Analysis**
**Los Angeles Area (Los Angeles & Orange Counties)**
(Assuming prices are 4 cents lower)

| | |
|---|---|
| **COSTS**: | |
| Total Conversion Cost | |
| RFGasoline (622 mbbls; approx. 2 tanks ... $3,055,000/tank x 2 tanks) | $6,110,000.00 |
| CARB Diesel (237 mbbls; approx. 1 tanks ... $2,305,000/tank x 1 tank) | 2,305,000.00 |
| Permitting and Miscellaneous (10% of above total) | 841,500.00 |
| **Subtotal** | **$9,256,500.00** |
| Initial Inventory Cost | |
| RFGasoline ($29.00/bbl ... 622,000 bbls x $29.00/bbl) | $18,038,000.00 |
| CARB Diesel ($30.00/bbl ... 237,000 bbls x $30.00/bbl) | 7,110,000.00 |
| **Subtotal** | **$25,148,000.00** |
| **Total Initial Cost** | **$34,404,500.00** |
| Annualized Cost (assuming 20 year life) | $4,433,890.44 |
| Annual Storage Cost @ $0.30/bbl/mth) | $3,092,400.00 |
| **Total Annualized Cost** | **$7,526,290.44** |
| **TOTAL BENEFITS:** | |
| Annual gasoline consumed in LA area, bbls (Caltrans data) | 109,389,286 |
| Weekly gasoline consumed in LA area, bbls | 2,103,640 |
| Weekly diesel consumed in LA area (Caltrans data) | 274,000 |
| Weekly increased disposable income @ $1.68/bbl or 4 cents/gal. ((2,103,640 + 274,000) x $1.68/bbl) | $3,994,435.38 |
| Total disposable income saved ($3,994,435.38/wk x 1 week) (Storage volume will last about 1 week if the LA area loses about 100,000 bbls/d of gasoline & and equivalent amount of diesel productive capacity) | $3,994,435.38 |
| **TOTAL DISBENEFITS** | |
| Total disbenefit from restocking (assuming one release per year) | |
| Restocking generates a disbenefit because large purchases of petroleum products will push prices higher than they otherwise would have been | |
| **Assume** restocking takes four weeks and prices are on average four cents/gallon higher (the disbenefit: 4 wks x 0.04 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $15,977,741.54 |
| **Assume** restocking takes four weeks and prices are on average two cents/gallon higher (the disbenefit: 4 wks x 0.02 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $7,988,870.77 |
| **Assume** restocking takes four weeks and prices are on average zero cents/gallon higher (the disbenefit: 4 wks x 0.00 $/gal. x 42 gals./bbl x (2,103,640 + 274,000)) | $0.00 |

The information from Table #6 produced the results shown in Table #8 (case with prices 8 cents lower).

**Table #8**
**Results of Benefit-Cost Analysis**
**(Total Net Benefits/Total Cost)**
Price lowered by 8 cents

| Price During Restocking | Benefit Cost Ratio** |
|---|---|
| Four cents/gallon higher | -0.112 |
| Two cents/gallon higher | 0.447 |
| Zero cents/gallon higher | 1.007 |

**Benefit-Cost Ratio = (Total Annual Benefits - Total Disbenefits) / Total Annualized Cost

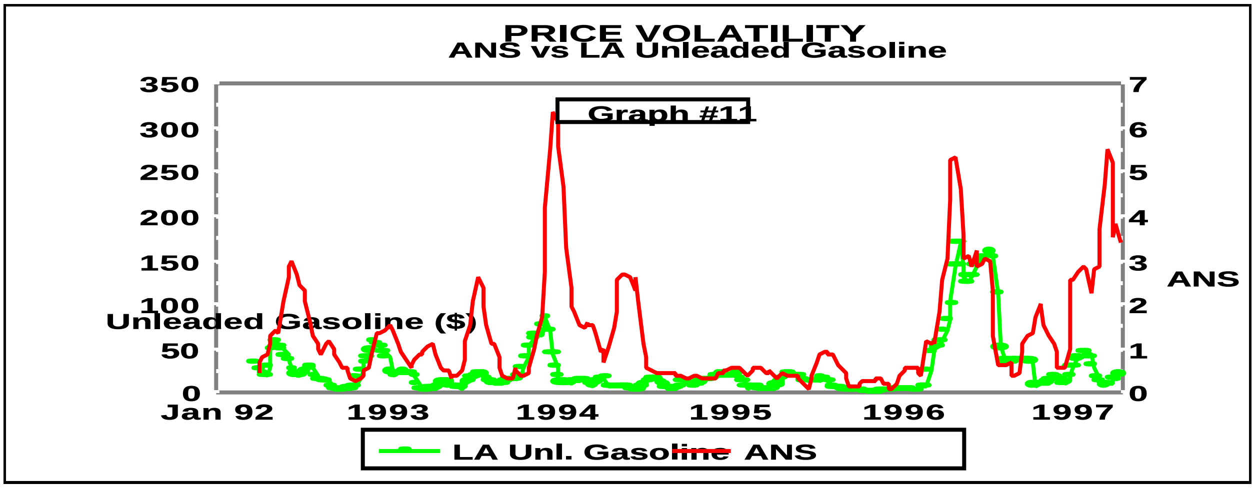
The information from Table #7 produced the results shown in Table #9 (case with prices 4 cents lower).

**Table #9**
**Results of Benefit-Cost Analysis**
**(Total Net Benefits/Total Cost)**
Prices lowered by 4 cents

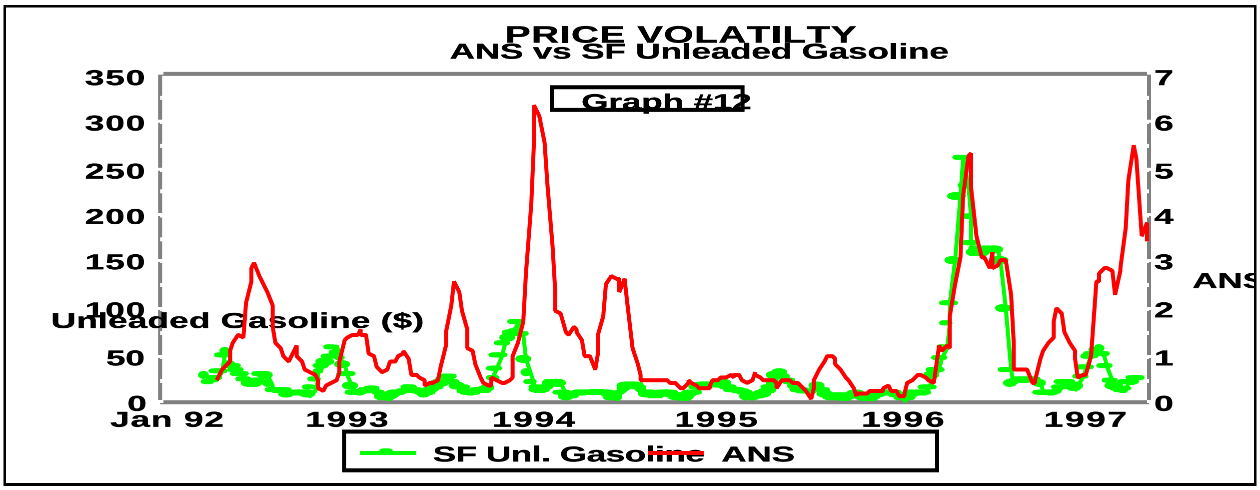
| Price During Restocking | Benefit Cost Ratio** |
|---|---|
| Four cents/gallon higher | -1.592 |
| Two cents/gallon higher | -0.531 |
| Zero cents/gallon higher | 0.531 |

**Benefit-Cost Ratio = (Total Annual Benefits - Total Disbenefits) / Total Annualized Cost

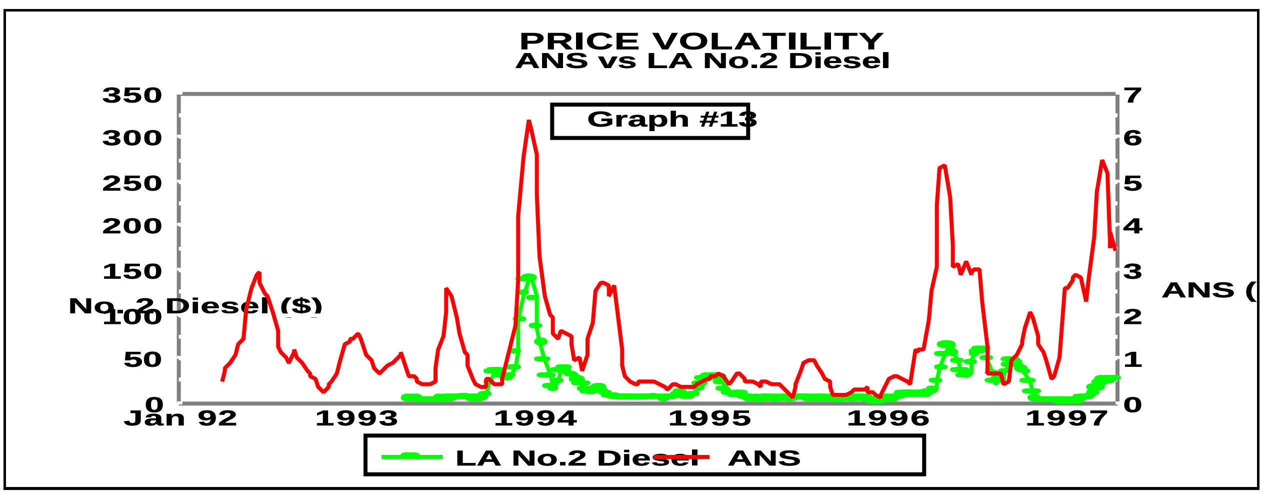
# Appendix C



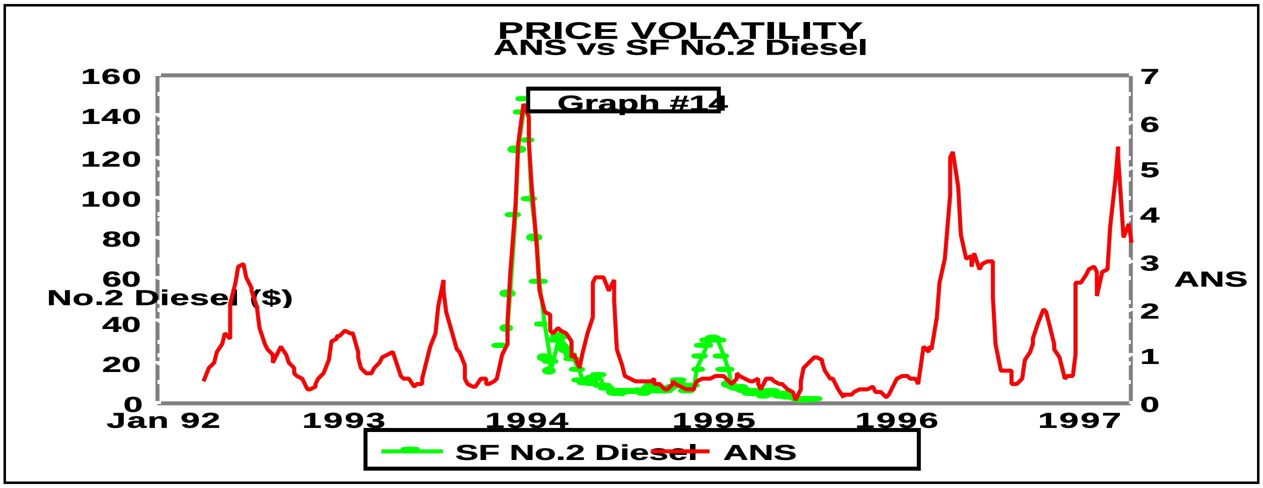
PRICE VOLATILITY
ANS vs LA Unleaded Gasoline
Graph #11
Unleaded Gasoline ($)
ANS
350
300
250
200
150
100
50
0
7
6
5
4
3
2
1
0
Jan 92
1993
1994
1995
1996
1997
LA Unl. Gasoline
ANS

PRICE VOLATILTY
ANS vs SF Unleaded Gasoline
Graph #12
Unleaded Gasoline ($)
ANS
350
300
250
200
150
100
50
0
7
6
5
4
3
2
1
0
Jan 92
1993
1994
1995
1996
1997
SF Unl. Gasoline
ANS

PRICE VOLATILITY
ANS vs LA No.2 Diesel
Graph #13
No. 2 Diesel ($)
ANS (
350
300
250
200
150
100
50
0
7
6
5
4
3
2
1
0
Jan 92
1993
1994
1995
1996
1997
LA No.2 Diesel
ANS




Note: No. 2 diesel data was not reported beyond mid-1995.